HelloWorld程序实验手册

版本：1.0

华为技术有限公司

目录

1 课程介绍

1.1 简介

本书适用于学习并行计算课程的学生进行实验练习，完成本实验手册后，您将能更加充分理解集群 MPI 并行计算的搭建、配置及运行，掌握在华为鲲鹏上如何运行。

1.2 内容描述

本实验指导书通过在华为鲲鹏上，编译运行简单的 HelloWorld 示例程序。完成实验操作后，读者会掌握简单的程序编写，集群 MPI 并行计算的配置以及加深对并行计算的了解。

1.3 读者知识背景

本课程为并行计算基础课程，为了更好地掌握本书内容，阅读本书的读者应首先具备以下基本条件：

- 具备基本的 Linux 命令能力；

1.4 实验环境说明

- 华为鲲鹏云主机、openEuler 20.03 操作系统；
- 安装 mpich-3.3.2.tar.gz；
- 每套实验环境可供 1 名学员上机操作。

2 HelloWorld 示例程序

2.1 实验介绍

2.1.1 关于本实验

实现多台主机 mpi_hello_world 的编译运行。

2.1.2 教学目标

掌握多台主机 mpi_hello_world 的编译运行。

2.2 实验任务操作指导

2.2.1 创建示例程序源码

以下步骤均在 ecs-hw-0001 上执行。

执行以下命令，创建 hello 目录存放该程序的所有文件，并进入 hello 目录（四台主机都执行）

```
mkdir /home/zhangsan/hello
cd /home/zhangsan/hello
```

执行以下命令，创建示例程序源码 mpi_hello_world.c（四台主机都执行）

```
vim mpi_hello_world.c
```

代码内容如下：

```
#include <mpi.h>
#include <stdio.h>
int main(int argc, char** argv) {
// Initialize the MPI environment. The two arguments to MPI Init are not
// currently used by MPI implementations, but are there in case future
// implementations might need the arguments.
MPI_Init(NULL, NULL);
// Get the number of processes
int world_size;
MPI_Comm_size(MPI_COMM_WORLD, &world_size);
// Get the rank of the process
int world_rank;
```

```
MPI_Comm_rank(MPI_COMM_WORLD, &world_rank);
// Get the name of the processor
char processor_name[MPI_MAX_PROCESSOR_NAME];
int name_len;
MPI_Get_processor_name(processor_name, &name_len);
// Print off a hello world message
printf("Hello world from processor %s, rank %d out of %d processors\n",
processor_name, world_rank, world_size);
// Finalize the MPI environment. No more MPI calls can be made after this
MPI_Finalize();
}
```

```
#include <mpi.h>
#include <stdio.h>
int main(int argc, char** argv) {
        // Initialize the MPI environment. The two arguments to MPI Init are not
        // currently used by MPI implementations, but are there in case future
        // implementations might need the arguments.
        MPI_Init(NULL, NULL);
        // Get the number of processes
        int world_size;
        MPI_Comm_size(MPI_COMM_WORLD, &world_size);
        // Get the rank of the process
        int world_rank;
        MPI_Comm_rank(MPI_COMM_WORLD, &world_rank);
        // Get the name of the processor
        char processor_name[MPI_MAX_PROCESSOR_NAME];
        int name_len;
        MPI_Get_processor_name(processor_name, &name_len);
        // Print off a hello world message
        printf("Hello world from processor %s, rank %d out of %d processors\n",processor_name, world_rank, world_size);
        // Finalize the MPI environment. No more MPI calls can be made afterthis
        MPI_Finalize();
        }
```

2.2.2 创建 makefile

执行以下命令，创建 makefile（四台主机都执行）

```
vim makefile
```

代码内容如下：

```
EXECS=mpi_hello_world
MPICC?=mpicc
all: ${EXECS}
mpi_hello_world: mpi_hello_world.c
${MPICC} -o mpi_hello_world mpi_hello_world.c
clean:
rm -f ${EXECS}
```

```
EXECS=mpi_hello_world
MPICC?=mpicc
all: ${EXECS}
mpi_hello_world: mpi_hello_world.c
        ${MPICC} -o mpi_hello_world mpi_hello_world.c
clean:
        rm -f ${EXECS}
```

2.2.3 进行编译

执行以下命令，进行编译（四台主机都执行）

```
cd /home/zhangsan/hello
make
```

```
[zhangsan@ecs-hw-0001 hello]$
[zhangsan@ecs-hw-0001 hello]$ ll
total 8.0K
-rw------- 1 zhangsan zhangsan 155 Jul  3 19:37 makefile
-rw------- 1 zhangsan zhangsan 871 Jul  3 19:36 mpi_hello_world.c
[zhangsan@ecs-hw-0001 hello]$
[zhangsan@ecs-hw-0001 hello]$ make
mpicc -o mpi_hello_world mpi_hello_world.c
[zhangsan@ecs-hw-0001 hello]$
[zhangsan@ecs-hw-0001 hello]$ ll
total 24K
-rw------- 1 zhangsan zhangsan 155 Jul  3 19:37 makefile
-rwx------ 1 zhangsan zhangsan 70K Jul  3 19:41 mpi_hello_world
-rw------- 1 zhangsan zhangsan 871 Jul  3 19:36 mpi_hello_world.c
[zhangsan@ecs-hw-0001 hello]$
```

2.2.4 建立主机配置文件

执行以下命令，建立主机配置文件（四台主机都执行）

```
vim /home/zhangsan/hello/config
```

添加内容如下：

```
ecs-hw-0001:2
ecs-hw-0002:2
ecs-hw-0003:2
ecs-hw-0004:2
```

```
[zhangsan@ecs-hw-0001 hello]$ more config
ecs-hw-0001:2
ecs-hw-0002:2
ecs-hw-0003:2
ecs-hw-0004:2

[zhangsan@ecs-hw-0001 hello]$
```

2.2.5 运行监测

执行以下命令，查看运行结果（只需要在 ecs-hw-0001 上执行）

```
mpiexec -n 8 -f /home/zhangsan/hello/config /home/zhangsan/hello/mpi_hello_world
```

结果如下：

```
[zhangsan@ecs-hw-0001 hello]$ mpiexec -n 8 -f /home/zhangsan/hello/config /home/zhangsan/hello/mpi_hello_world

Authorized users only. All activities may be monitored and reported.

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Authorized users only. All activities may be monitored and reported.
Hello world from processor ecs-hw-0001, rank 0 out of 8 processors
Hello world from processor ecs-hw-0004, rank 6 out of 8 processors
Hello world from processor ecs-hw-0003, rank 4 out of 8 processors
Hello world from processor ecs-hw-0002, rank 2 out of 8 processors
Hello world from processor ecs-hw-0001, rank 1 out of 8 processors
Hello world from processor ecs-hw-0004, rank 7 out of 8 processors
Hello world from processor ecs-hw-0003, rank 5 out of 8 processors
Hello world from processor ecs-hw-0002, rank 3 out of 8 processors
[zhangsan@ecs-hw-0001 hello]$
[zhangsan@ecs-hw-0001 hello]$ mpiexec -n 8 -f /home/zhangsan/hello/config /home/zhangsan/hello/mpi_hello_world

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Hello world from processor ecs-hw-0001, rank 0 out of 8 processors
Hello world from processor ecs-hw-0001, rank 1 out of 8 processors
Hello world from processor ecs-hw-0003, rank 4 out of 8 processors
Hello world from processor ecs-hw-0004, rank 6 out of 8 processors
Hello world from processor ecs-hw-0002, rank 2 out of 8 processors
Hello world from processor ecs-hw-0003, rank 5 out of 8 processors
Hello world from processor ecs-hw-0004, rank 7 out of 8 processors
Hello world from processor ecs-hw-0002, rank 3 out of 8 processors
[zhangsan@ecs-hw-0001 hello]$
```

通过上述代码运行，可以看出，编写的 hello-wolrd 程序已经在华为鲲鹏上运行起来，程序在集群之间并行计算处理。

2.3 思考题及答案

思考下集群之间如果彼此不配置信任秘钥，程序能否正常运行?

参考答案：不能，因为集群之间需要并行运行来处理相关程序，如果只是在单台主机上配置信任秘钥，从其它主机是不能无密登录访问到该主机，信息不能同步，无法并行处理。

说明：《高性能与并行计算》课程配套实验手册中的实验内容由上海交通大学计算机科学与工程系吴晨涛老师提供，华为公司负责实验手册文档的编写。